1999 Entomology Project Report - WSDA PUB 034 (N/1/00)
Laboratory Services Division, Pest Program
Washington State Department of Agriculture

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1999 Western Washington *Tipula oleracea* Survey (Diptera: Tipulidae)

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Background

Figure 1. **Adult Female *Tipula oleracea***

The crane fly turf pest known as the **European crane fly** in the Pacific Northwest, ***Tipula paludosa* Meigan**, is an introduced exotic pest first found in the region in 1965 in British Columbia, Canada. Since then, it has gradually spread into Washington State, Western Oregon and Northern California, and has become the most serious economic pest of lawns, pastures and hayfields in the region.

In 1998, a second, closely related crane fly species from Europe was found in the Pacific Northwest. Bob Costello, an entomologist with the British Columbia Ministry of Agriculture and Food, noted unusually early spring crane fly development in areas near Vancouver, Canada, and submitted specimens subsequently identified by the Biosystematics Research Institute in Ottawa as a European species new to North America (Costello, 1998). The new species, ***Tipula oleracea*** L. ,(Fig. 1) is almost identical in appearance to *T. paludosa* and is similar biologically. However, *T. oleracea* can complete two generations per year (European crane fly has one) and adult *T. oleracea* emerge in the spring as well as the fall, when most European crane flies emerge. *T. oleracea* is also considered a serious pest of turf and other plants in its native Europe. In response to the detection of *T. oleracea* in B.C., this survey was developed and funded in cooperation with the United States Department of Agriculture / Animal and Plant Health Inspection Service (USDA APHIS) to determine the presence and/or distribution of *T. oleracea* in Washington State. Funds for field activities were provided through a Western Region USDA APHIS Cooperative Agricultural Pest Survey (CAPS) grant, to detect or delimit an exotic pest species new to the United States.

1999 Project Objectives

1. Determine survey methods
- Acquire or identify physical characters, if possible, for species level identification of larval and/or adult crane flies and evaluate their utility for this survey.
- Determine suitable field collection or trapping methods to conduct larval and/or adult survey.

2. Detect or delimit *T. oleracea* distribution in Washington State.
- Conduct surveys to detect or delimit *T. oleracea* in as large an area of Western Washington as resources allow.

3. Collect biological data to begin characterizing *T. oleracea* biology, phenology, and impacts in Washington State.

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Project Methods and Results

Survey Methods Development- Identification of *T. oleracea* larvae and adults.

Larval specimens examined to assess identification procedures were collected in March from turf in several areas in northwestern Washington. Specimens were collected using a variety of random digging (by hand) techniques as well as quantifiable plug-cut sampling methods using a golf hole cutter. Larvae were hand picked from excavated soil or turf roots (while shredding and/or rinsing the root mass in water), then rinsed to remove adhering soil (if needed) and immersed in boiling water for about 60 seconds prior to storage in 80% alcohol.

Identification of the *T. oleracea* larvae is largely a matter of differentiating between the larvae of *T. oleracea* and *T. paludosa,* a process which proved to be problematic and inconclusive in this survey. The similarity of larvae of the two species is reflected in the early attempts to describe the larvae of European crane flies. A 1958 publication, describing the last instar larvae of 36 British Tipulidae crane flies concludes the differences between *T. oleracea* and *T. paludosa* larvae "cannot be distinguished" (Criswell, 1958).

A subsequent larval description suggests larvae of the two species can be separated by differences in the shape of ventral projections on the posterior end of the larvae (Brindle, 1960). Illustrations of the key larval structures from that publication, presented here as figures 2 and 3, seem to show distinct differences in the ventral projections, labeled VP (ventral papillae) in figure 2.

However, examination of preserved, field collected late-instar larval specimens found a wide variation in shape of the key structures. Observed variation in shape likely represents naturally occuring variability (possibly including age and larval condition) as well as physical changes due to specimen preparation (rinsing/boiling), preservative (alcohol) induced shrinking, and other handling effects. Some examples of the range of variation observed are presented below (fig.4).

Figure 2. *T. paludosa* larval characters (from Brindle, 1960).

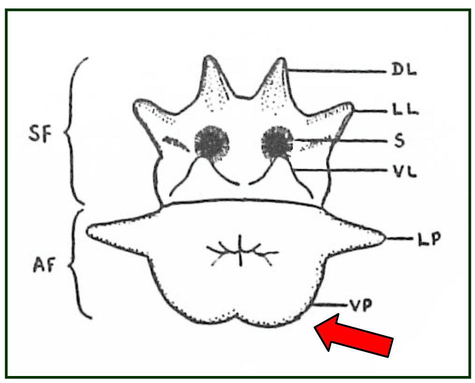


Figure 3. ***T. oleracea*** larval characters (from Brindle, 1960)

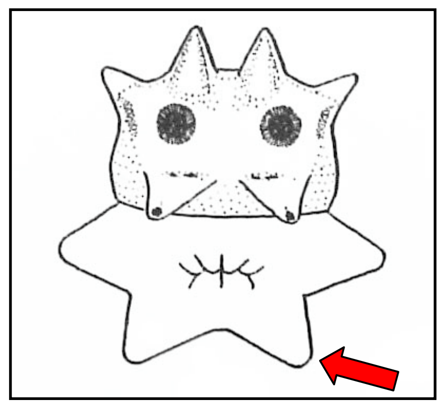


Figure 4. Variation in shape of ventral papillae among three crane fly larvae.

Due to this variation between specimens and the seemingly subjective nature of species determinations based on this physical character, this identification technique was not applied in this survey. Additional work, possibly involving alternative (standardized) specimen handling techniques and structural analysis, is needed before this character is readily applicable for species identification.

Identification of *T. oleracea* larvae and adults (Cont.)

A different physical character for separating *T. oleracea* and *T. paludosa* larvae has been described by George Byers, based on differences he observed in the pattern of microscopic hairs (setae) on identified larval specimens from Russia (G. Byers, personal communication and (Savchenko, 1961)). Unfortunately, attempts to apply the methodology to identify larvae collected in this survey were also inconclusive, suggesting possible variation of larval morphology (from geographically distant populations) and/or clarification of the character and refinement of the identification technique is needed.

In contrast, identification of adult *T. oleracea* and *T. paludosa,* which also are very similar overall, was simple and unambiguous due to clear physical characters. A very clear character for distinguishing the two species is the separation of the compound eyes on the ventral surface (underside) of the head (From Brodo, 1994), as shown in the following figures.

Figure 5. Underside of ***T. oleracea*** head.

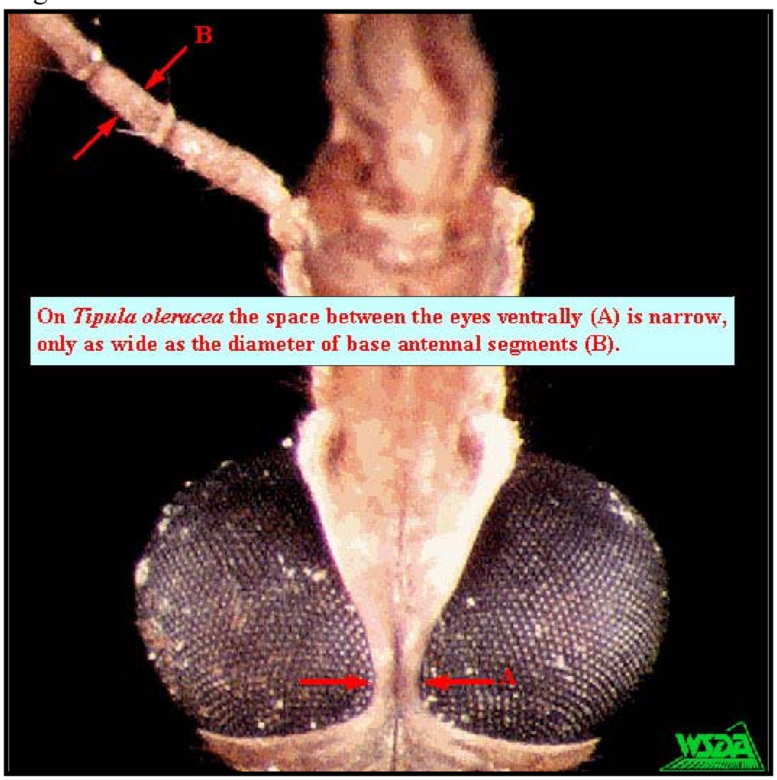
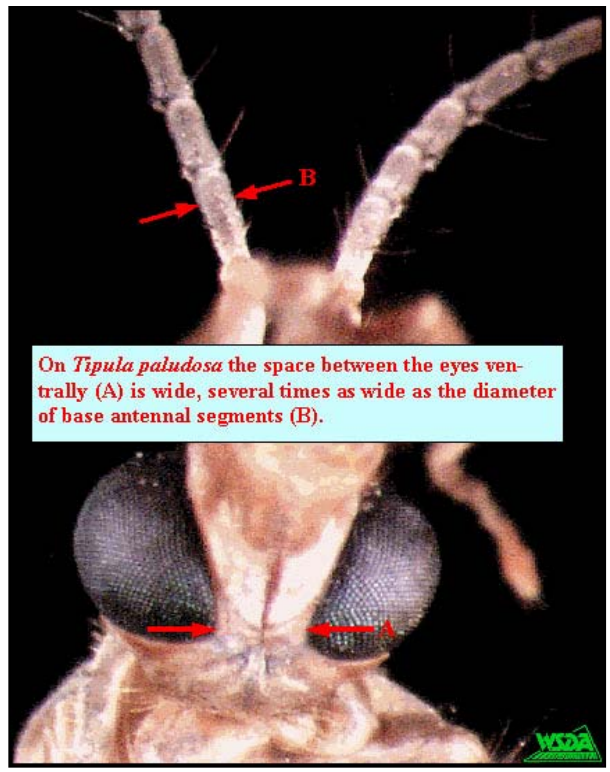


Figure 6. Underside of ***T. paludosa*** head.



A different character to separate the species, which applies only to <u>females</u>, is length of wings. Female *T. oleracea* wings are clearly longer than the abdomen as shown in figure 7, whereas wings of female *T. paludosa* are shorter than the abdomen.

Figure 7. Female ***T. oleracea*** wings

A more complete description of adults of both exotic species and comparison pictures of similar native crane fly species have been compiled as an internet web page and is accessible via the WSDA web site at: http://www.wa.gov/agr/index.htm. Internet website posting of identification information is expected to offer several dynamic advantages over print publication, thus only the key identifying characters are presented here. Information and graphics in digital format may be freely copied directly from the web page and updates and new identification resources may be added to the web site as they are developed.

Survey Methods - Collection / Trapping Procedures

Larval collecting methods considered, as mentioned in the preceding section, included random hand digging and extraction from turf roots as well as quantified sampling using a golf hole plug-cutter. However, when larval identification efforts were unsuccessful within the resources and timeframes of this project, larval sampling was discontinued. Subsequently, only strategies for collecting and trapping adult crane flies were tested and applied beginning in April and continuing until the observed end of adult flight in October.

Several adult collecting approaches were tested, including several forms of passive trapping techniques, active (attraction based) trapping, and ultimately hand or net collecting. Passive trap tests included both emergence and flight intercept (Malaise type) traps. **Emergence trapping** for many kinds of flying insects that develop on or in the ground can be done very economically using simple cardboard boxes, placed open side down (on the ground), with a clear jar or large vial screwed into the side. Adult insects emerging into the box are attracted to the light of the jar opening and fly or crawl into the jar, where they are easily seen and collected. However, there are numerous significant drawbacks to the technique. The traps are highly subject to tampering in public areas, and finding locations where the traps are protected and can be left in place for more than a few days is difficult. Primary problems (or concerns) include; boxes cause lawn discoloration and spindly growth, are an impediment to mowing and maintenance, are unattractive, and require frequent entry of survey staff onto property for servicing. Additionally, inherent physical problems with the approach include: rain and wind protection, spiders and other predators in the boxes destroy captive adult insects, some insects don't enter or stay in the collecting jar. This last element may be the most limiting factor for use of emergence-box traps for crane fly sampling, as adults are weakly attracted to light. Emergence-box traps were tested at several sites in May to investigate adult *T. oleracea* emergence from different habitats, but were largely ineffective and discontinued after 1 month.

An inexpensive **flight intercept trap** was tested, using intersecting white sheet panels and a plastic collector-funnel top similar to a Malaise trap. The collecting principal is based on the tendency of flying insects to fly upward when they encounter a solid barrier, and is an effective survey technique for many kinds of true flies if traps are placed in open "fly ways". The trap was tested in several locations, but failed to collect any adult crane flies.

Figure 8. Adult crane fly sampling with modified light traps

Adult craneflies are attracted to artificial lights, and several techniques for trapping attracted adults were tested, including the **modified light traps** shown in figure 8. The hanging traps were constructed from intersecting 1/4" plexiglass panels, standard BioQuip® aluminum funnels inserted into plastic catch bins, and 160 watt, self-ballasted mercury vapor lights (also from BioQuip®). Catch bins were used with either baffles to contain trapped insects or dry ice wrapped in newspaper to paralyze trapped insects with concentrated carbon dioxide.

Survey Methods - Collection / Trapping Procedures (Cont.)

The modified plexiglass/funnel collector **light traps**, which work well for collecting moths and other nocturnal flying insects, proved to be very ineffective for trapping adult crane flies, even though adult crane fies were attracted to the vicinity of the lights from the surrounding area. To try to increase trap catch, the hole at the bottom of the funnel was enlarged from 1¼" (32 mm) diameter to 2½" (64 mm), and additional lights (without panels) and multiple adjacent traps were tried. None of these modifications noticably improved trap catch. Several water traps, consisting of a few inches of soapy water in various size and height containers (i.e. 10 gal aquaria, baking pans, etc.) were also placed below the light traps to try a different strategy to capture adults attracted to the area around the lights. These also collected very few specimens. Ultimately, the majority of adult craneflies collected around the light traps were captured by hand or aerial net.

Some **hand and aerial net collections** were done, both day and night (around various lights), but largely when opportunities presented themselves and were more or less random collections. Some time was dedicated specifically to visual search and hand net collecting, but within the timeframes and resources of this project, was generally too inefficient a technique to use extensively. The same was true for **sweep net sampling**, which was about as productive as visually spotting and hand netting adults, and much more labor intensive.

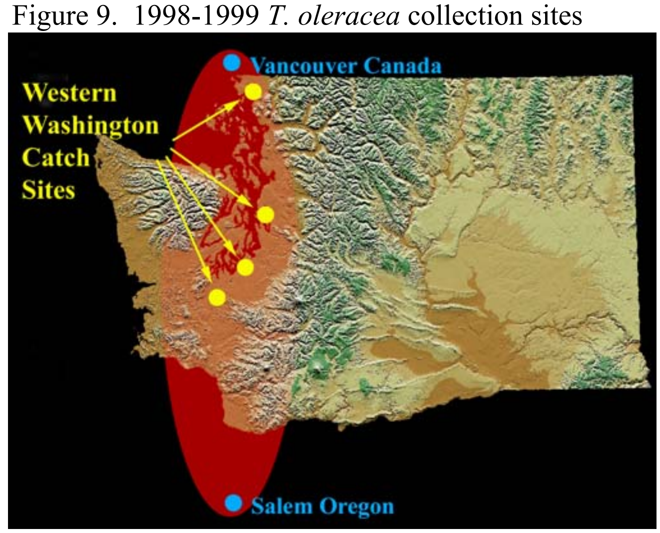
Detecting / Delimiting *T. oleracea* Distribution in Washington State

As mentioned above, efforts to identify *T. oleracea* larvae were unsuccessful, which precluded the use of larval collection as a detection or delimiting technique in this project. The development of a dependable larval identification technique could facilitate future surveys, but more importantly, is a critical prerequisite to future work on the biology and impacts of *T. oleracea* in North America.

The first identified adult *T. oleracea* specimens found via this project were confirmed by Prof. George Byers, University of Kansas (Systematic Entomology Lab collaborating scientist), May 6, 1999, and consisted of 4 adults collected at two very interesting locations Two of the confirmed specimens, which were the first adult *T. oleracea* collected in 1999, actually came from Western Oregon, captured at the Salem area residence of Dr. Barry Bai, Entomologist with the Oregon Department of Agriculture. They were two male *T. oleracea* , captured by hand at the Bai residence by Todd Murray on April 1, 1999. The other two confirmed specimens were two adult female *T. oleracea,* collected July 20,1998 in light trap sampes at the authors residence near Tenino, in Thurston county, Washington State. Those adult female specimens, collected 1998, are currently the first recorded U.S. collections.

The simultaneous confirmation of *T. oleracea* collections from Thurston county, Washington, and the Salem area in Marion county, Oregon, rather abruptly established a (likely contiguous) distribution of *T. oleracea* that spans all of Western Washington (Figure 9). The distance from Salem, Oregon to Vancouver, Canada is approximately 375 miles. With the apparent early flight season establishment of contiguous distribution of *T. oleracea* across the Western Washington survey area, subsequent adult collections were continued with the objective of determining adult flight phenology. All together, 56 adult *T. oleracea* were collected in four Western Washington counties in this survey, including 3 in 1998 and 53 in1999, with the total number collected by county as follows: Whatcom - 32, King - 1, Pierce - 7, Thurston - 16.

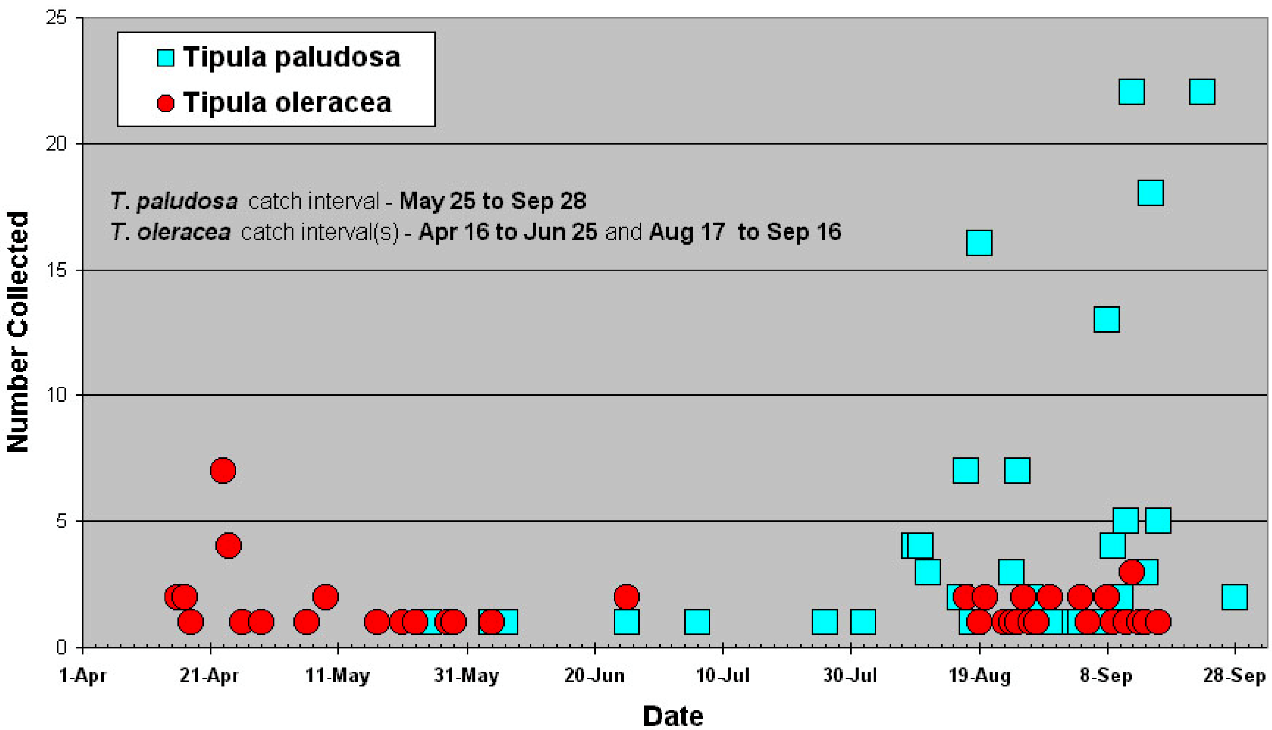
Figure 9. 1998-1999 *T. oleracea* collection sites



Biological data characterizing *T. oleracea* biology, phenology, and impacts in Washington State.

The lack of effective larval identification techniques limited the biological investigation aspects of this project to adult monitoring, and efforts to sample adults quantitatively (i.e. emergence and light trapping) were unproductive. As a result, the adult collection data gathered in this project must be recognized as largely random and unquantified sampling, even though hand sampling at light traps was often conducted in a similar manner many evenings throughout the course of the project. However, while unquantified, the catch data does represent a relatively consistent effort to detect and collect adult crane flies present for the purposes of determining the **1999 flight phenology for *T. oleracea* and *T. paludosa*.** All adult collections for both species are summarized in Figure 10.

Figure 10. 1999 Adult *T. oleracea* and *T. paludosa* collections in Washington State



The catch data, as expected, does suggest a single, relatively continuous flight period for *Tipula paludosa*, and two separate flight periods for *Tipula oleracea*, reflecting the two generations per year biology described for the species in the European literature (Alford, 1991). *Tipula paludosa* adults were collected from May 5 until September 28, although sporadically and in low numbers from first catch until early August, and high catch numbers during September suggest a peak of flight activity around the middle of that month. *Tipula oleracea* adults were collected from April 16 until June 25, and August 17 to September 16, with catch numbers during the first catch interval suggesting a possible peak in flight activity in late April.

The widespread distribution of *T. oleracea* clearly shows that this “new” introduced species has been present in the Pacific Northwest for many years. How it went unnoticed as it became established here and spread throughout the Pacific Northwest is easy to speculate, since it so closely resembles the European crane fly. However, another significant contributing factor is that residents of the region have become accustomed to the damage and costs that “crane flies” inflicted over the last 20 years. The widespread and chronic nature of “crane fly” damage to turf in diverse commercial and private settings in the region is now common knowledge, but the actual economic impacts are poorly described in the technical literature and associated costs have never been calculated or estimated.

Characterizing *T. oleracea* biology, phenology, and impacts in Washington State (Cont.).

For this project, a brief survey was conducted to estimate one facet of the economic costs of crane fly control in Western Washington - that of **private homeowner applied pesticide treatments for "european crane fly"**. Information sources and estimates compiled were as follows:

- Information was solicited from 3 owners or managers of prominent pest control businesses in economically contrasting areas of the Puget Sound metropolitan area (Whitworth et. al., 1999).
- Current estimates were requested by telephone interview for: percentage (range) of homeowners in business area that do their own cranefly treatments, what they use, and average size of lawns.
- The total number of residences in Western Washington used to calculate total estimated costs was from a Washington State Office of Fiscal Management report, Population Trends – 1999 (OFM, 1999).

Other gross/general assumptions for this estimate were: residents applied a single annual treatment for crane flies, and they used the most popular over-the-counter pesticide (Diazinon) at the recommended label rates, and the estimations garnered can be applied to the resident population of the rest of Western Washington (for crane fly prevalence and homeowner action). These estimates and asumptions produced the following calculations:

Average size of lawn:	4,833 ft.² **	
Approximate cost of Diazinon treatment per 1,000 ft.²:	$3.00	(concensus)
Average cost per residence:	$14.50	
Estimated number of residences in Western Washington in 1999:	1,923,137	(OFM, 1999)
Percentage of homeowners applying own crane fly treatments:	46.25% *	
Estimated number of residences applying own cranefly treatments:	889,259	
Average cost per residence:	$14.50	
Estimated total annual cost of homeowner applied crane fly treatments:	**$12,894,249**	

* - Range of estimates in different areas were; 30-35% (overall in Puget Sound metropolitan area, A. Antonelli), 10-30% (Tacoma - Parkland, suburban and rural Pierce county), 70-75% (Everett – Kent, King and Snohomish counties), 50-70% (Tacoma – Lakewood, Pierce county); Averages for range, low = (30+10+70+50)/4, high = (35+30+75+70)/4, gives average range of 40 – 52.5, mean of which is 46.25

** - Range of estimates, same order of areas as above; 3,000-5,000 ft.², 4,000-5,000 ft.², 5,000-7,000 ft.² ; Averages for range, low = (3,000+4,000+5,000)/3, high = (5,000+5,000+7,000)/3; gives range of 3,000-5,667 ft.², mean of which is 4,833 ft.².

Discussion

The economic background of *Tipula oleracea* in Europe is likely an ominous presage of it's impacts in North America. It's presence and widespread distribution now raise many questions regarding possible unrecognized current damage and potential future impacts. Many questions revolve around how *T. oleracea* is <u>different</u> from *T. paludosa*, and that fundamental question was the focus of much of the field and lab work in this project. The inability to differentiate between *T. oleracea* and *T. paludosa* larvae proved to be a major limitation to distribution survey. A practical method to identify larvae is a prerequisite to the investigation of the role of*T. oleracea* in on-going or future plant damage.

The estimate of homeowner applied treatment costs presented in this report, based on 1999 estimates and data, represents only part of the current costs for pesticide treatments for crane fly damage, and only the homeowner applied treatment costs in Western Washington. The cost of pesticide treatments to homeowners for professional spray services, to commercial property landscape managers, to golf courses, and to commercial turf farms and pasture managers may be several times that applied by homeowners. Add also similar costs that have been incurred in the British Columbia, Canada, and Western Oregon, and likely California in the near future. The current distribution of *T. oleracea* was not established in this survey. It is possible that it is now, or will soon be as widespread as *T. paludosa*.

Pertinent Literature

Alford, D. V. , 1991. A Colour Atlas of Pests of Ornamental Trees, Shrubs & Flowers. Wolfe Publishing Ltd., London, England

Antonelli, A. L. and G. Stahnke, 1998. European Crane fly: A Lawn and Pasture Pest. Washington State University College of Agriculture and Home Economics, Extension Bulletin EB0856, Revised July, 1998

Brindle, A. 1960. The larvae and pupae of the British Tipulinae (Diptera: Tipulidae), Transactions of the Society for British Entomology. Vol. 14, No. 3, pp. 63-114

Brodo, F. 1994. The subgenus *Tipula (Tipula)* in Finland and Estonia. Entomologica Fennica. 5: 49-52.

Costello, Bob 1998. October, 1998 Crop Protection Newsletter - B.C. Ministry of Agriculture and Food. Plant Industry Branch, Crop Protection Program, Vol. 20, No. 2,

Criswell, J. A. 1956 A Taxonomic Account of the Last Instar Larvae of some British Tipulinae (Diptera:Tipulidae) Trans. R. Ent. Soc. Lond. Vol 108, part 10, pp. 409-470+

Jackson, M. and R. L. Campbell 1975. Biology of the European Crane Fly, *Tipula paludosa* Meigan, in Western Washington (Tipulidae; Diptera), College of Agriculture Research Center Technical Bulletin No. 81, Washington State University, Pullman. July, 1975

Savchenko, 1961, Fauna of the U.S.S.R., vol 2, no. 3, p. 439

Washington State Office of Fiscal Management report (OFM), 1999, "Populations Trends – 1999", Table 7:Housing Units by Structure Type for Cities, Towns, and Counties. April 1, 1990 and April 1, 1999. (Numbers used are "Total" for each county. Structure Type categories in table include; One Unit, Two or more, MH/TR/Spec* w/ note - in areas where significant trailer outmigration occurred, the numbers will tend to be overestimated.)

Whitworth et al. 1999. Personal communication 1999; Telephone conversations between October 18 and December 2, 1999 with Puget Sound area Pest Control Operators: T. Whitworth, B. Harlan, and P. Tivoli.

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